



Assessment of HIRS OLR CDR Intersatellite Calibration Errors

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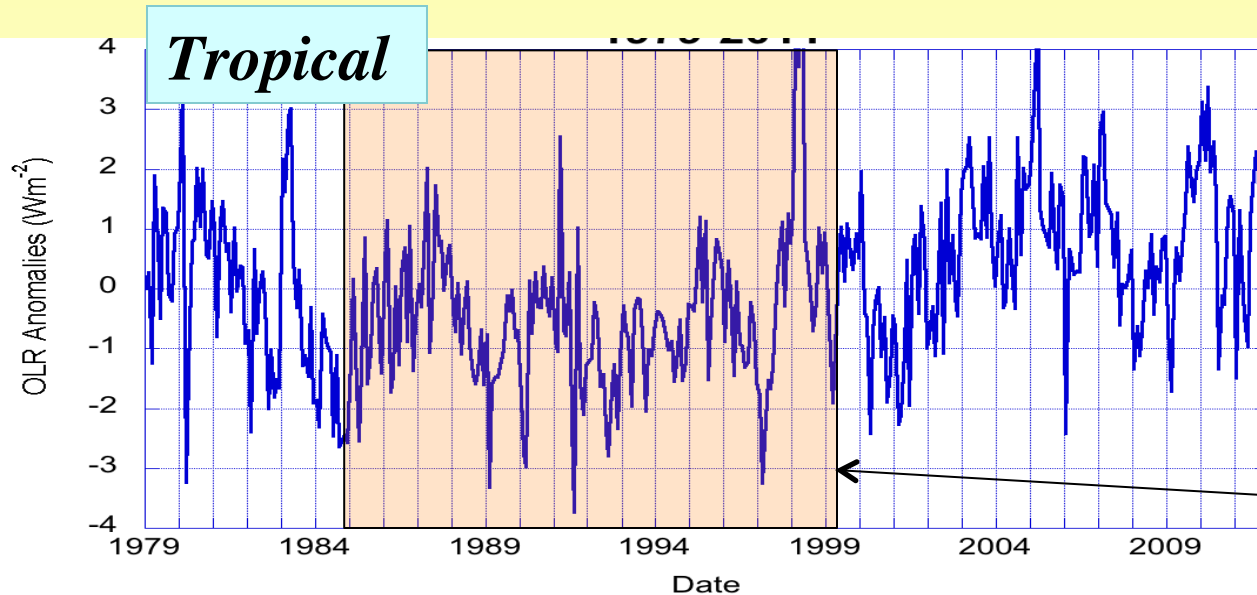
ESSIC-NOAA

University of Maryland, College Park, MD

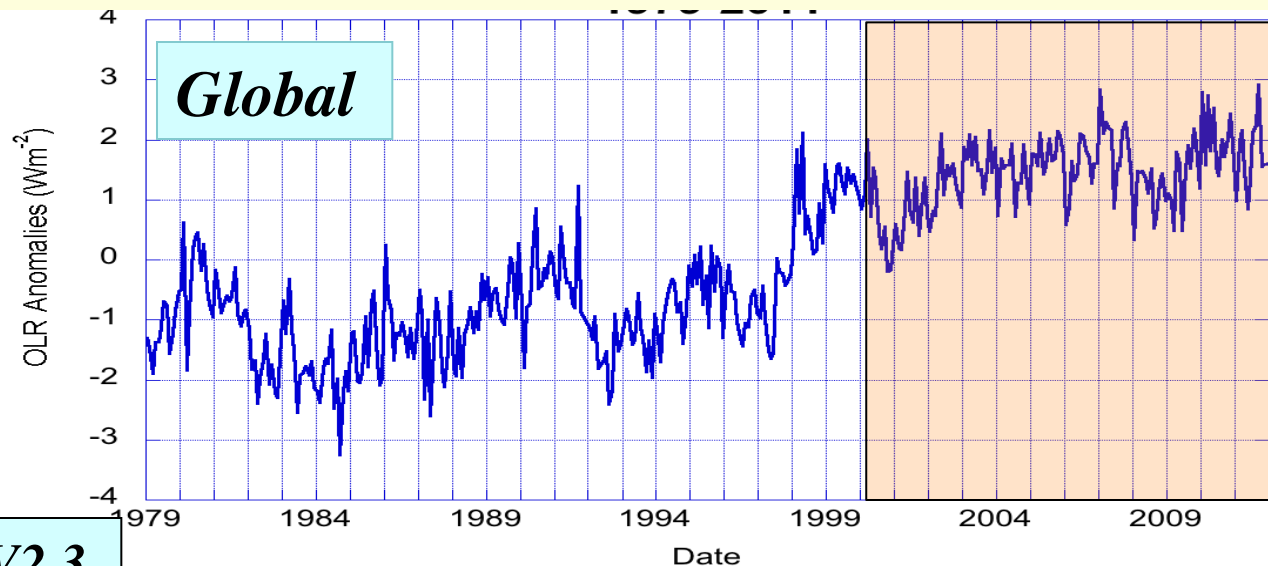
Background

- HIRS OLR CDR consists of observations from 16 NOAA and ESA operational polar-orbiting satellites, from 1979 – present.
- HIRS instruments have four variants: ver. 2, 2I, 3, and 4
- Current inter-satellite calibration method defines globally constant relative biases based on coincident observations, which mostly occurred in polar regions
- Spurious positive trend in global mean HIRS OLR time series was noticed that believed to be caused by intercal errors
- This study examined the algorithm-induced intersat biases, leading to a new inter-satellite calibration method.
- Updated inter-comparisons with ERBS and CERES

HIRS OLR Anomalies 1979-2011



*ERBS_NS
data period*



*CERES Terra/Aqua
data period*

Multi-spectral HIRS OLR Algorithm

Ellingson et al. (1989)

$$OLR = a_0(\theta) + \sum_i a_i(\theta) \cdot N_i(\theta)$$

a_i =regression coefficients

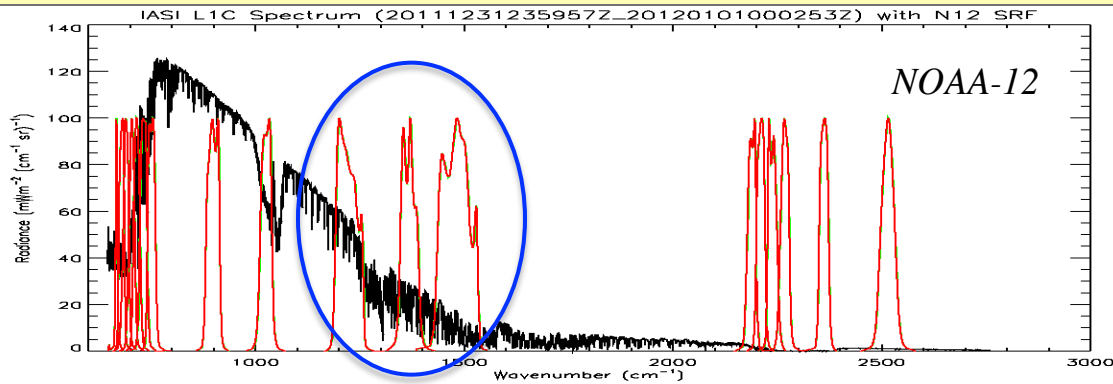
HIRS/2:

Channels: 3, 7, 10, 12

HIRS/2I/3/4:

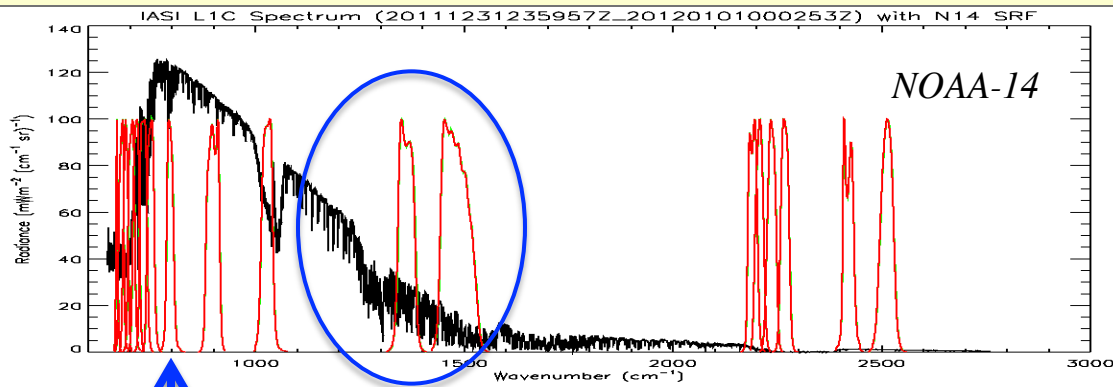
Channels: 3, 10, 11, 12

HIRS Instrument Variations



HIRS/2: TIROS-N, N06,...,10,12

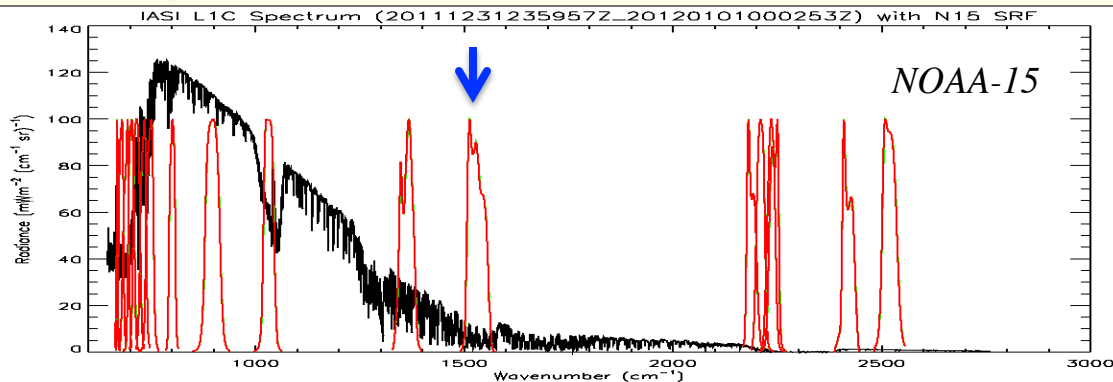
Three water vapor channels



HIRS/2I: N11,14

Lower tropospheric water vapor channel was removed

Replaced by a surface sensing channel at $12.47 \mu\text{m}$ (the new ch10)



HIRS/3: N15,16,18

HIRS/4: N19, MetOp-1,2

Upper tropospheric water vapor channel shifted towards band center

HIRS/4 enhanced FOV resolution

Assessment of Algorithm-induced Intersat Biases

Approach:

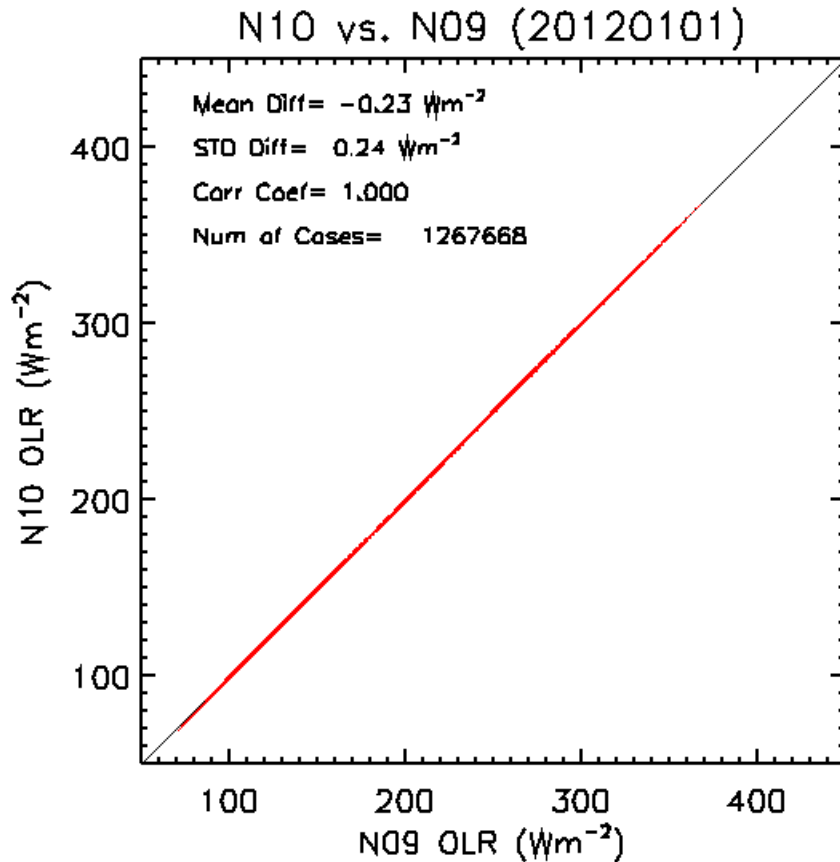
Emulate HIRS Radiance with IASI Spectrum Observations

- IASI Level-1c data (645-2760 cm^{-1})
- Convolute with HIRS SRF's
- Estimate OLR with HIRS OLR models
- *Virtually flying 16 “clean” HIRS instruments simultaneously (neglecting IASI noises)*

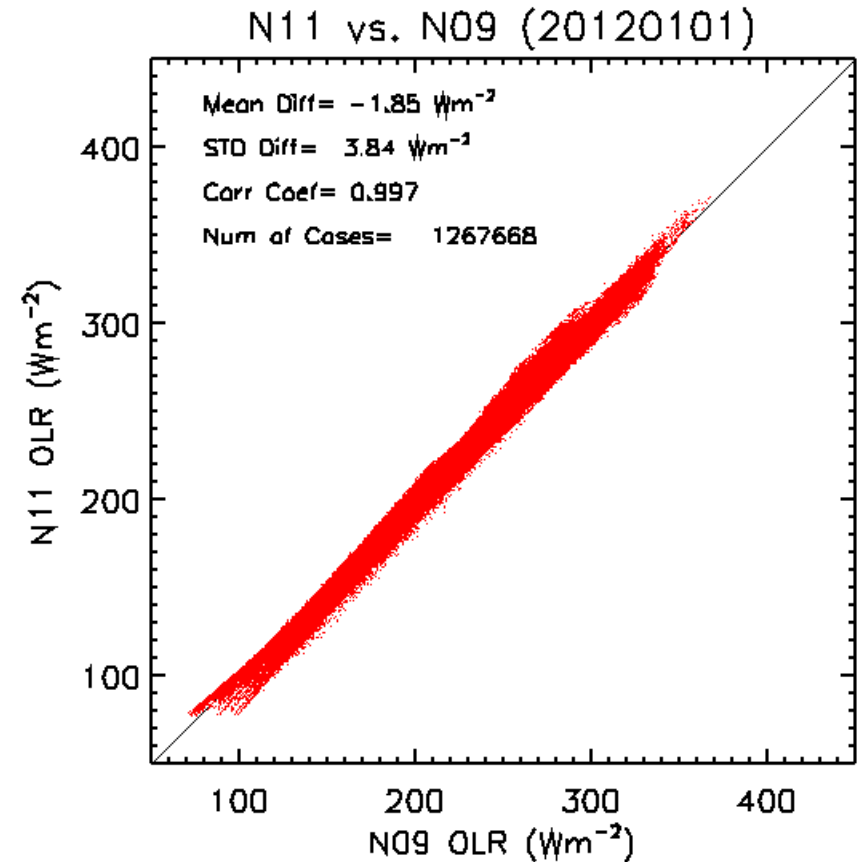
Examples of OLR Model Biases

Jan 1, 2012 (Effective FOV)

N10 vs N09



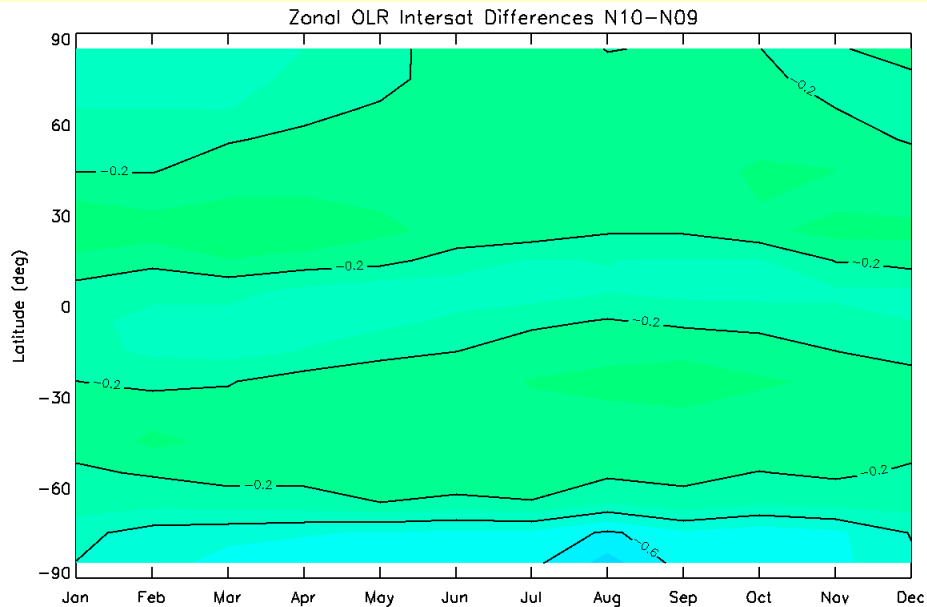
N11 vs N09



OLR Model Biases

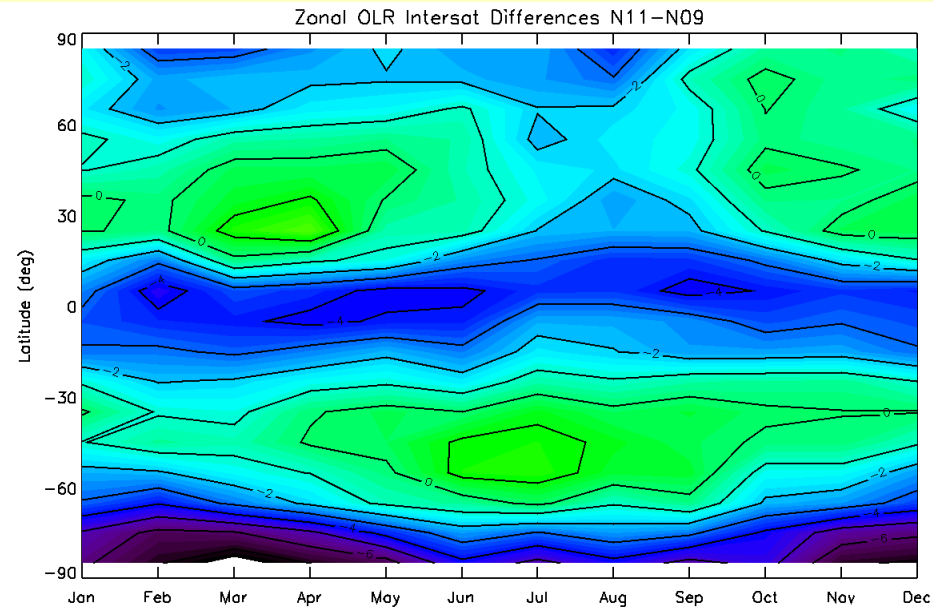
Latitudinal and Seasonal Variations

N10 – N09



Range: $[-0.6, 0] \text{ Wm}^{-2}$

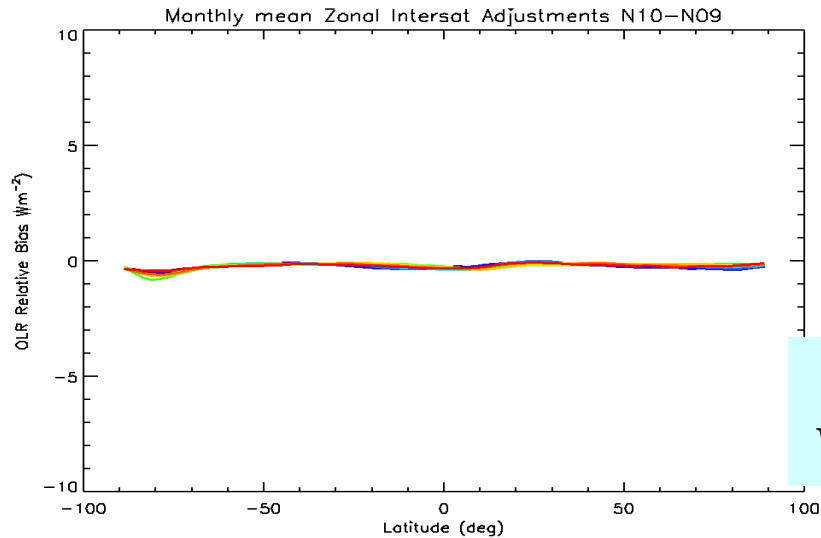
N11 – N09



Range: $[-10, 2] \text{ Wm}^{-2}$

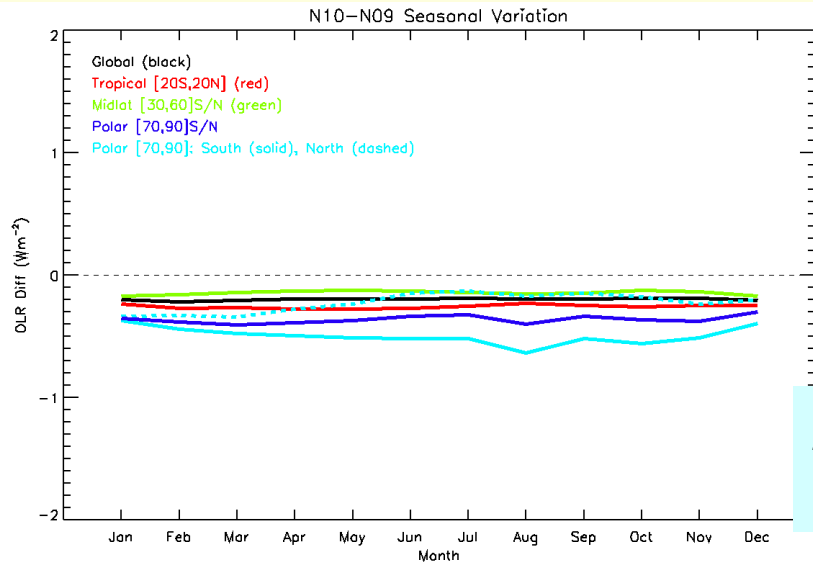
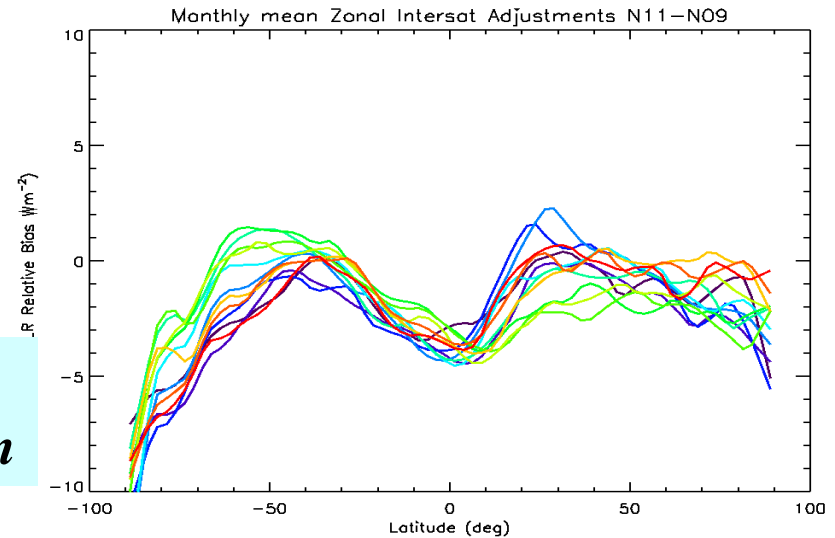
Variations in OLR Model Biases

N10 – N09

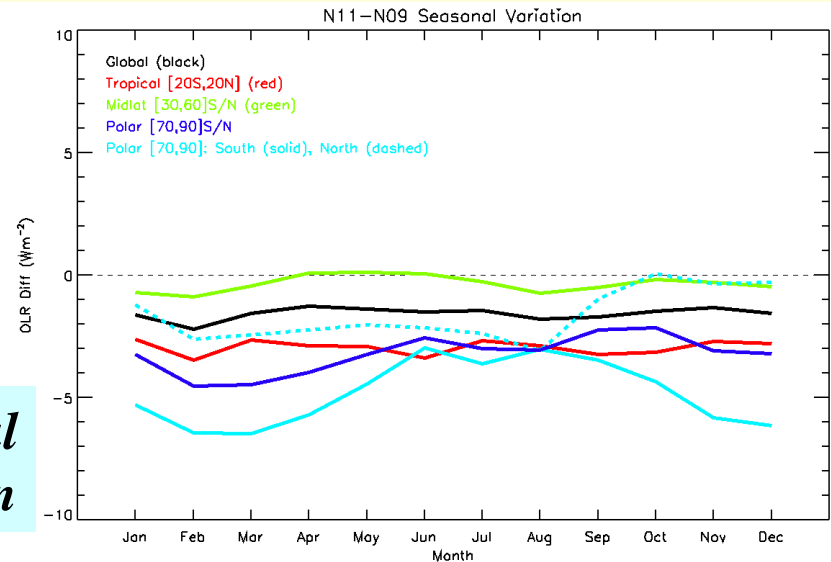


*Zonal
Variation*

N11 – N09



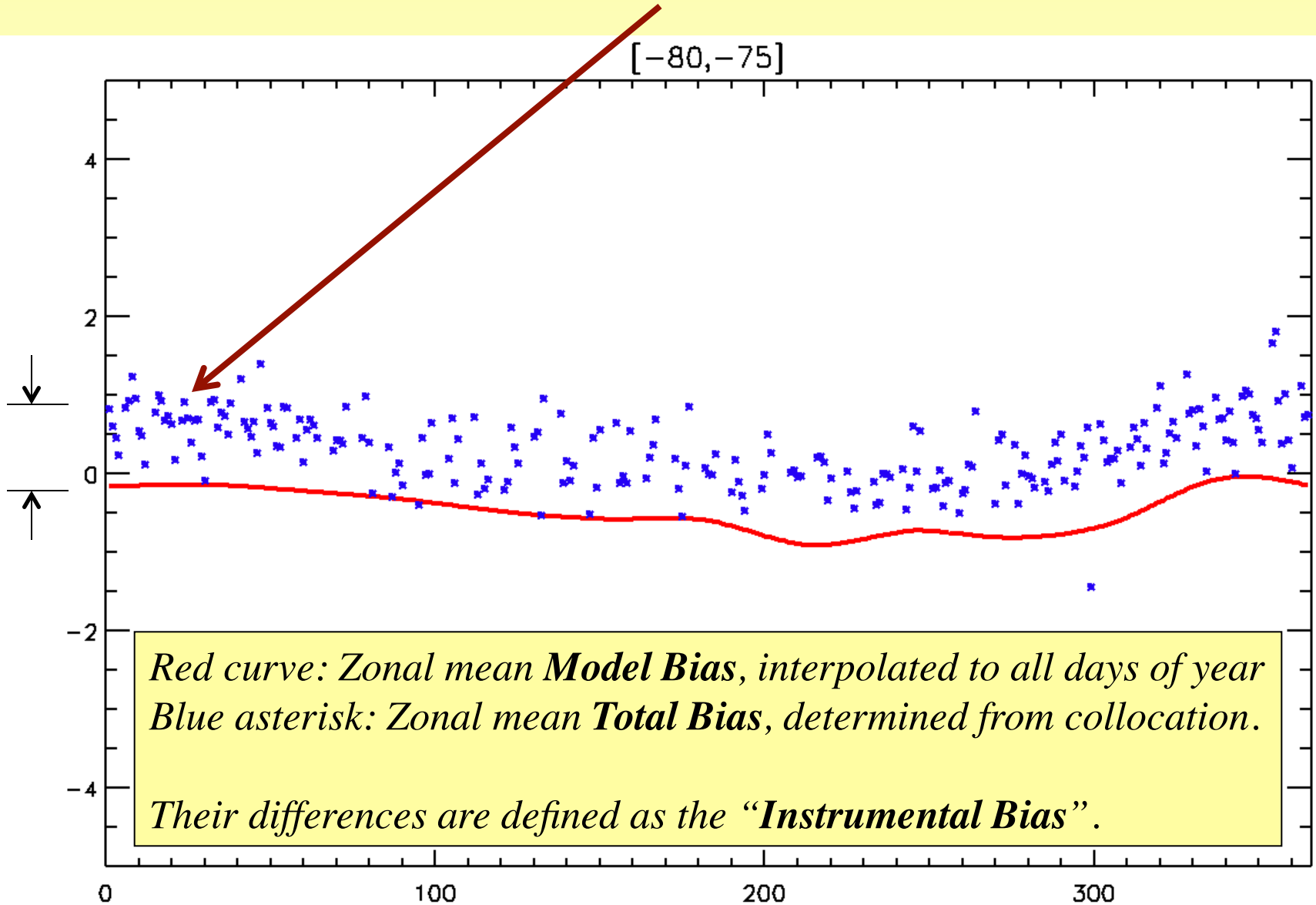
*Seasonal
Variation*



Assumption:

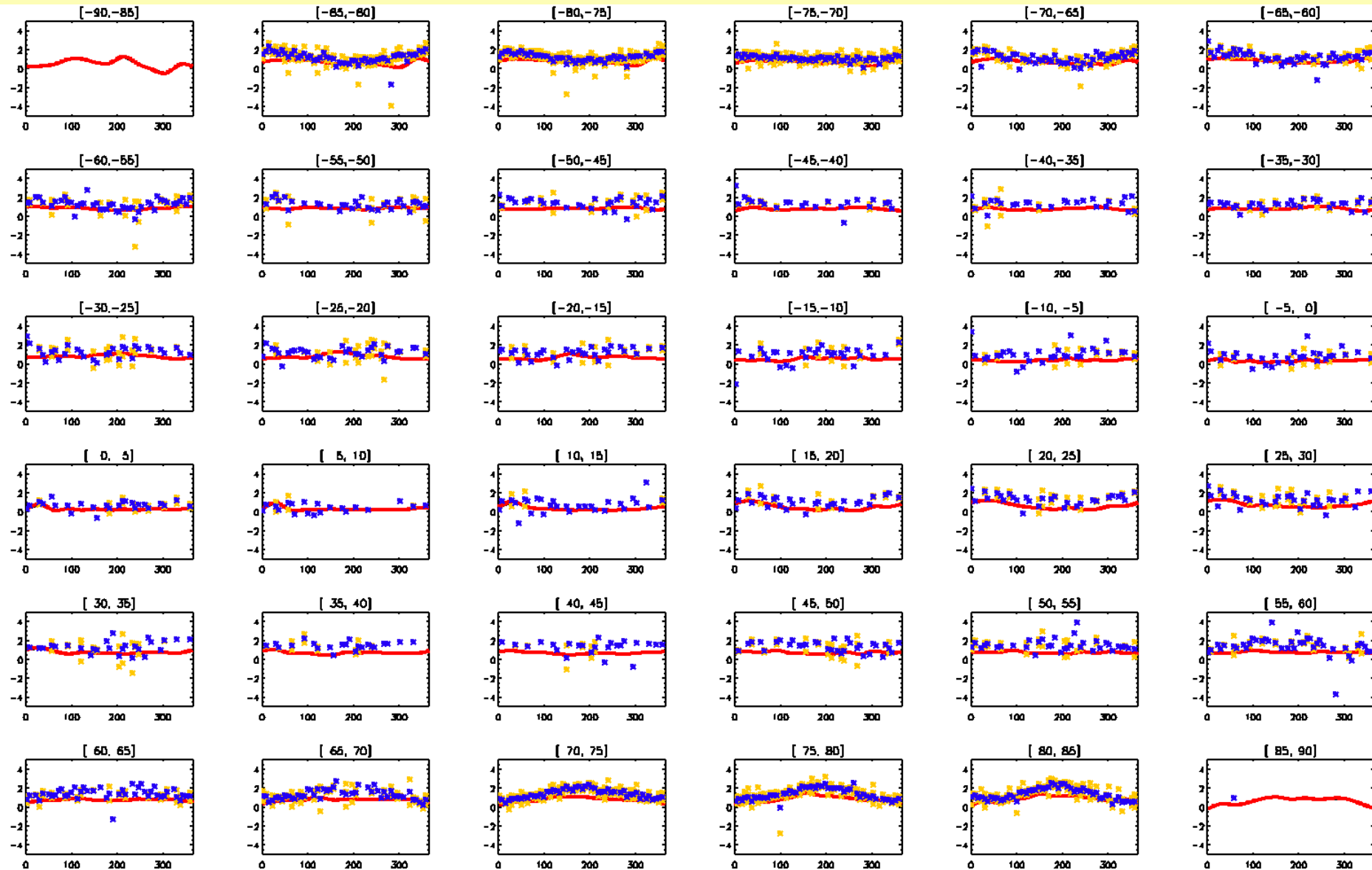
***Total Inter-satellite Bias =
Retrieval Algorithm + “Instrumental”***

Determination of “Instrumental Bias”



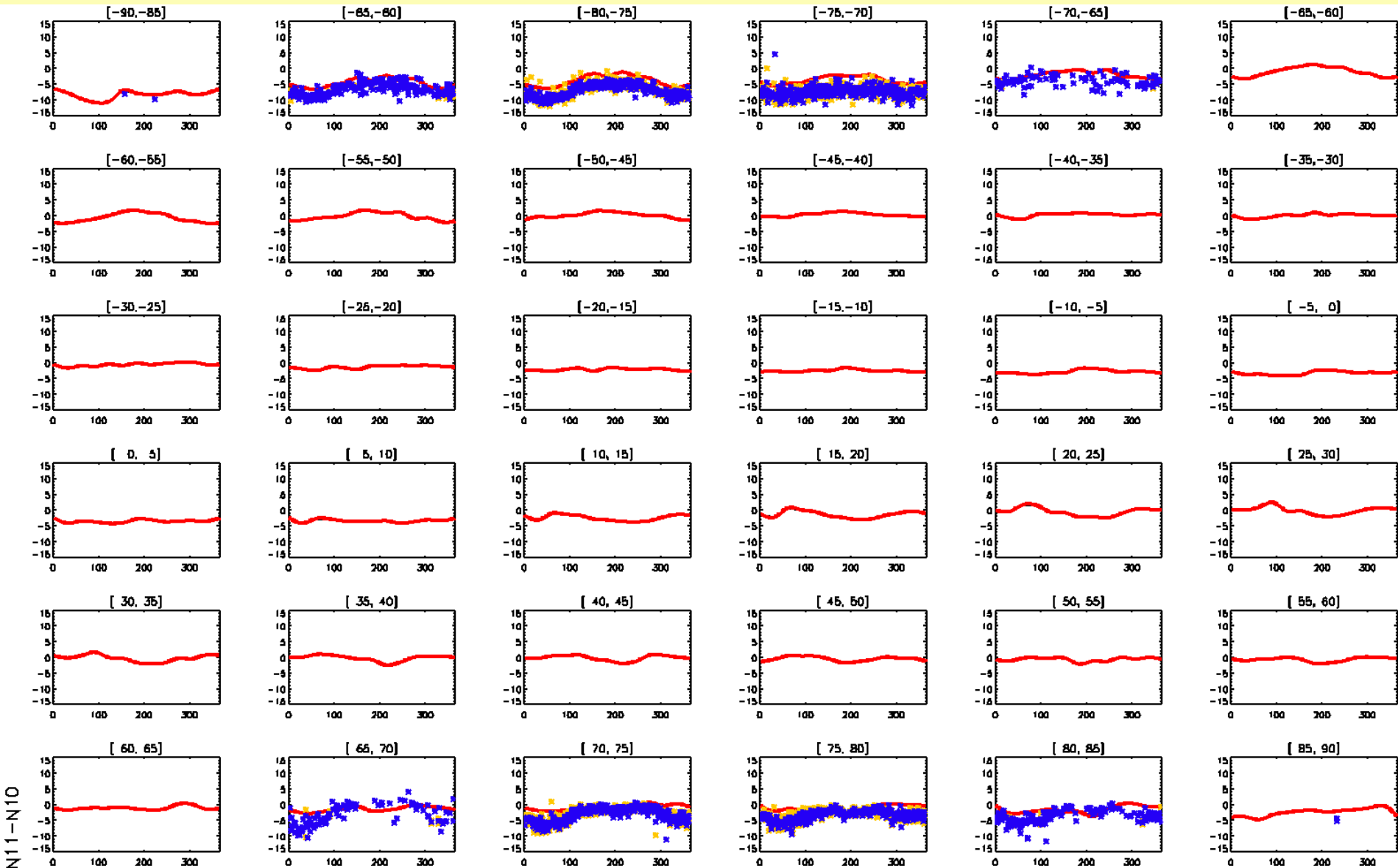
OLR Relative Bias for N15-N14

Latitudinal and Seasonal Variations



OLR Relative Bias for N11-N10

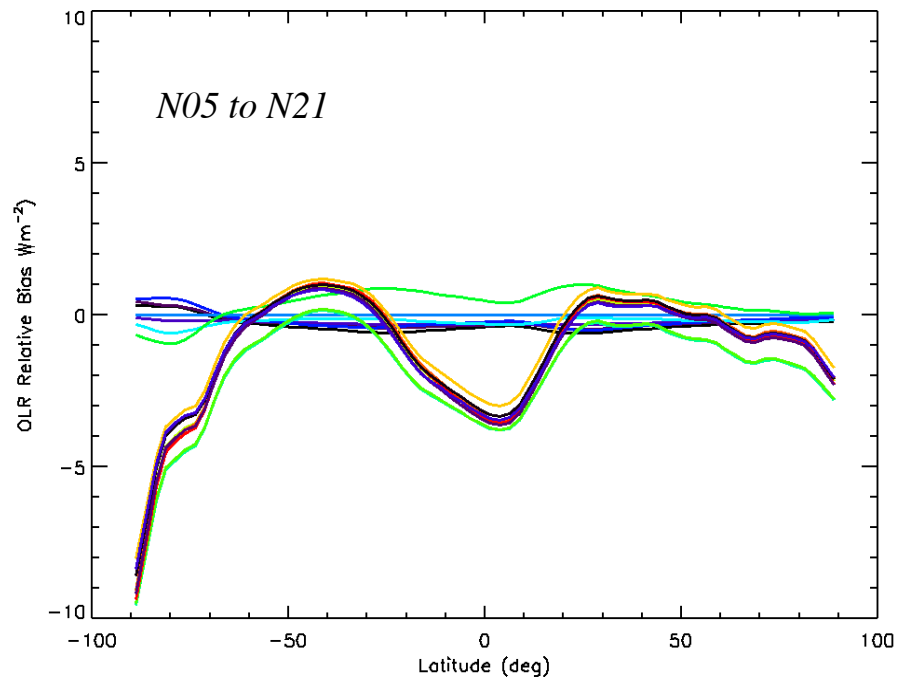
Latitudinal and Seasonal Variations



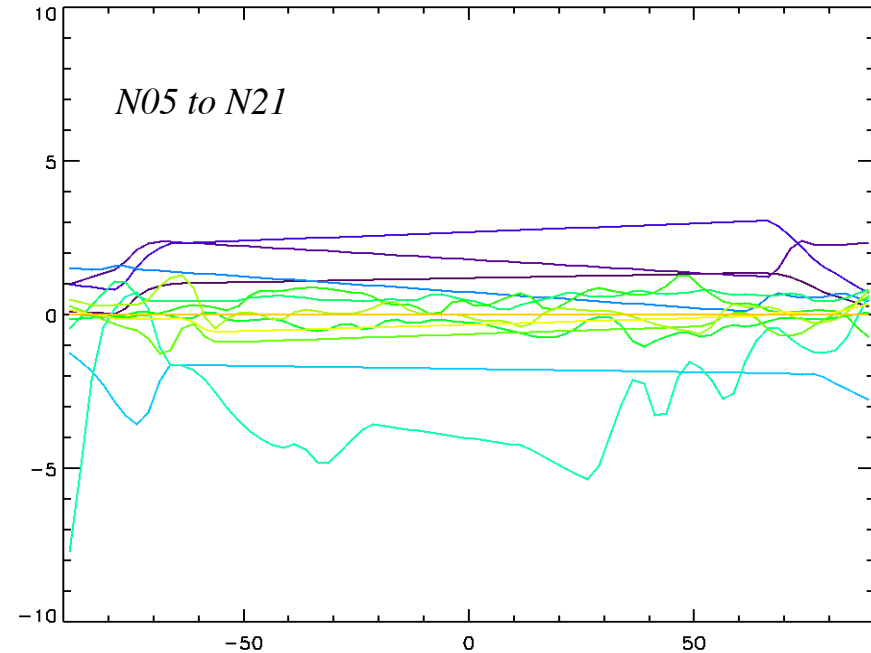
Annual Zonal OLR Relative Biases

ref.N09

Retrieval Model Biases

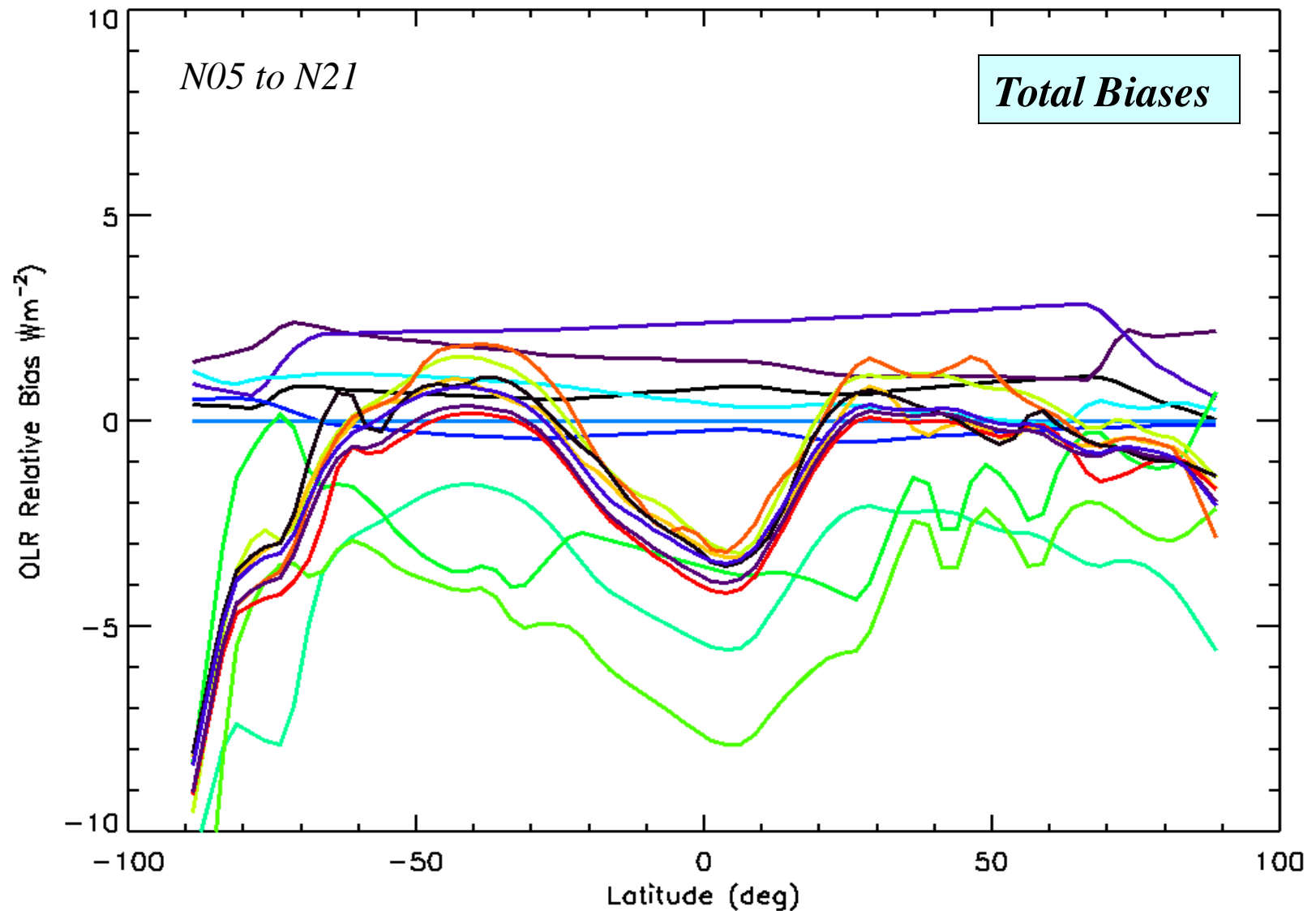


Instrumental Biases

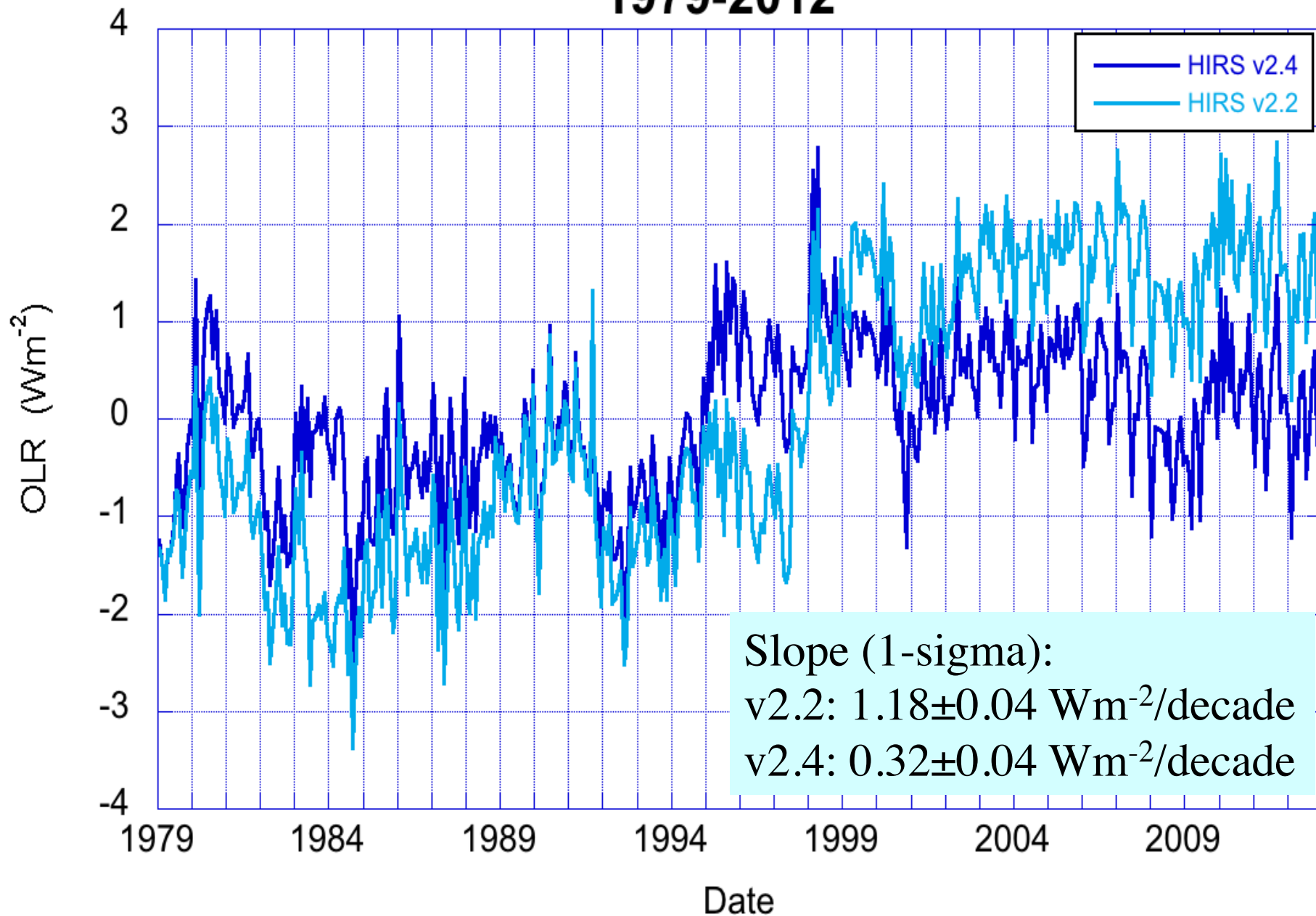


Annual Zonal OLR Relative Biases

ref.N09



Global Monthly OLR Anomaly 1979-2012

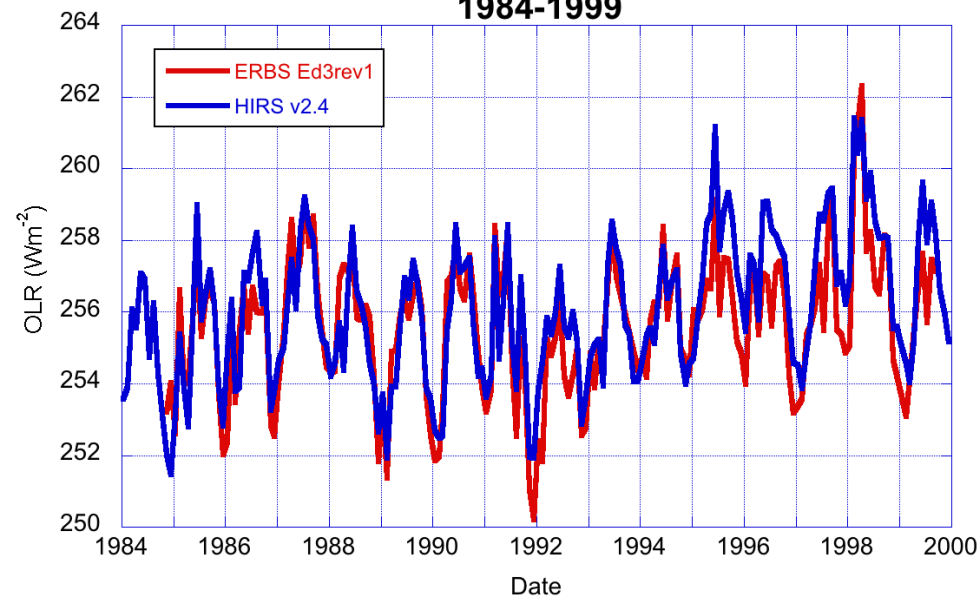


Inter-comparison Preliminary Results

Inter-comparison with ERBS-NS

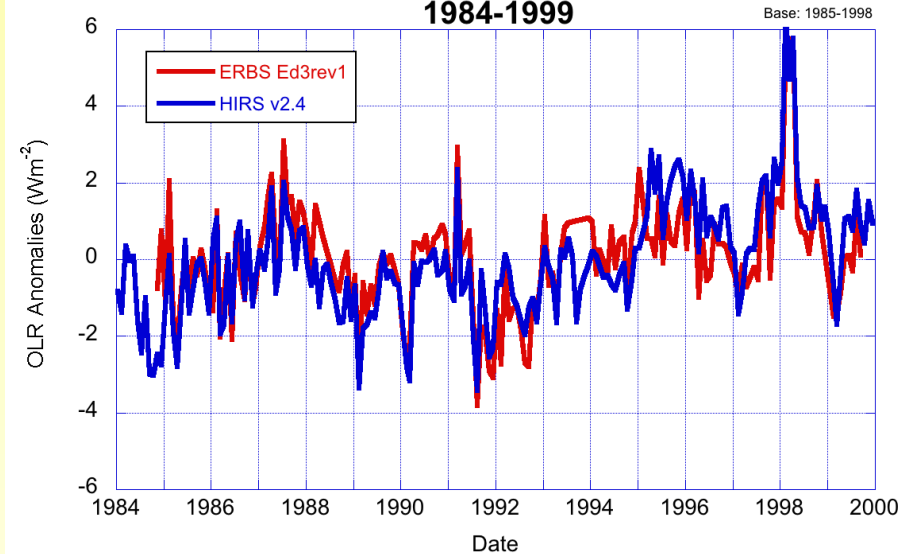
Tropical

**Tropical Monthly Mean OLR
1984-1999**

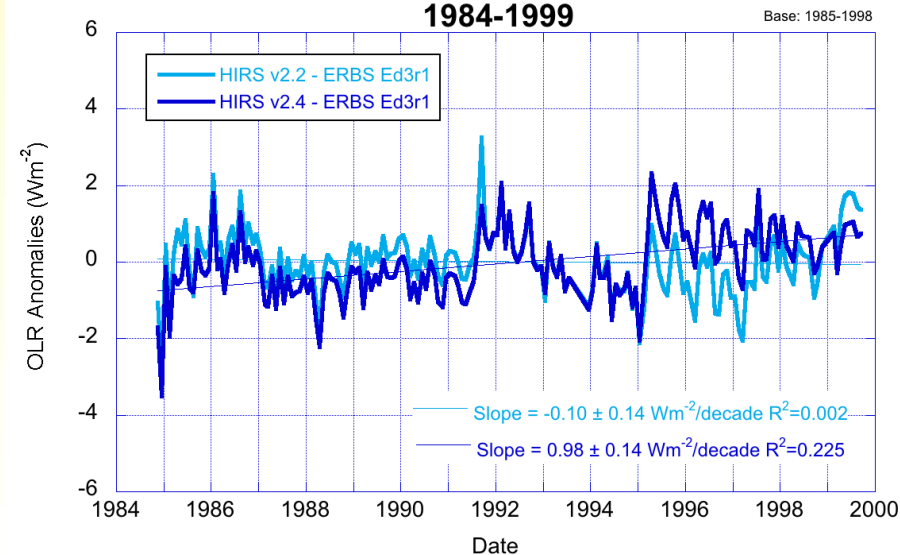


ERBS shifted by +4 Wm⁻²

**Tropical Monthly OLR Anomalies
1984-1999**



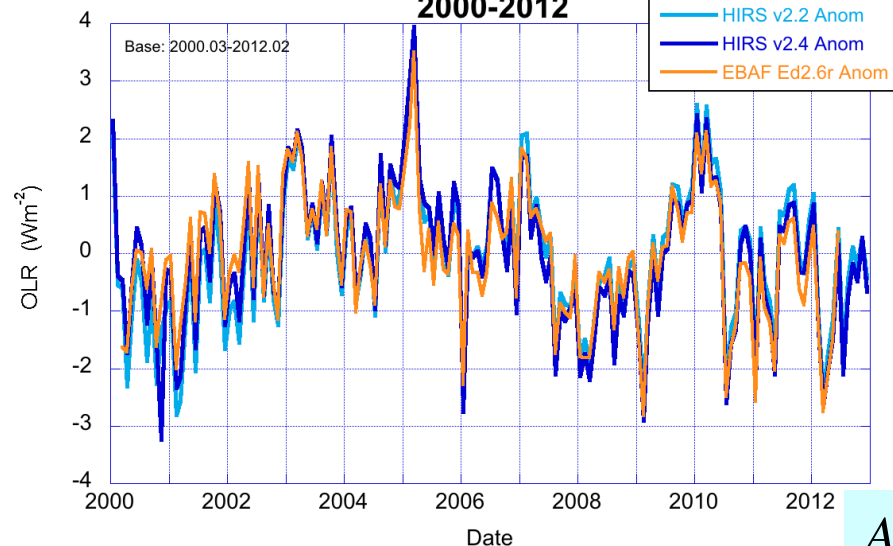
**Difference of Tropical Monthly OLR Anomalies
1984-1999**



Inter-comparison with CERES EBAF

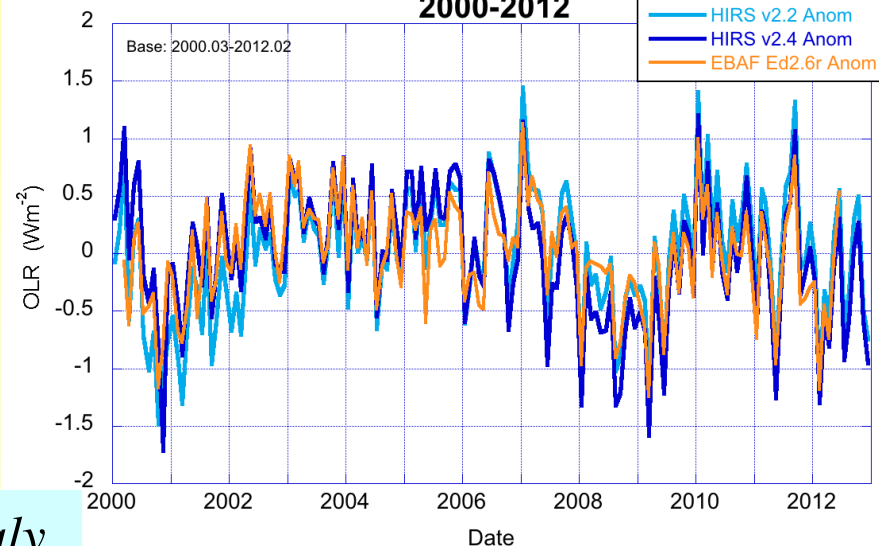
Tropical

**Tropical Monthly OLR Anomaly
2000-2012**



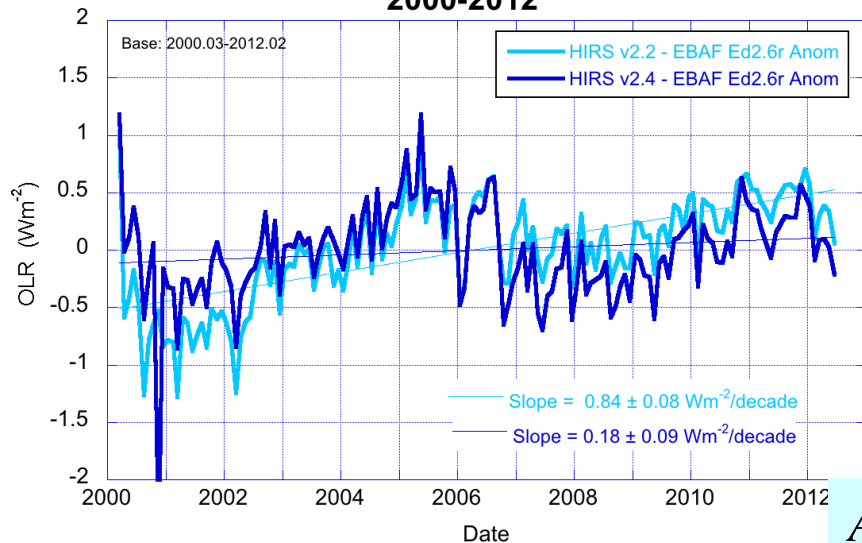
Global

**Global Monthly OLR Anomaly
2000-2012**

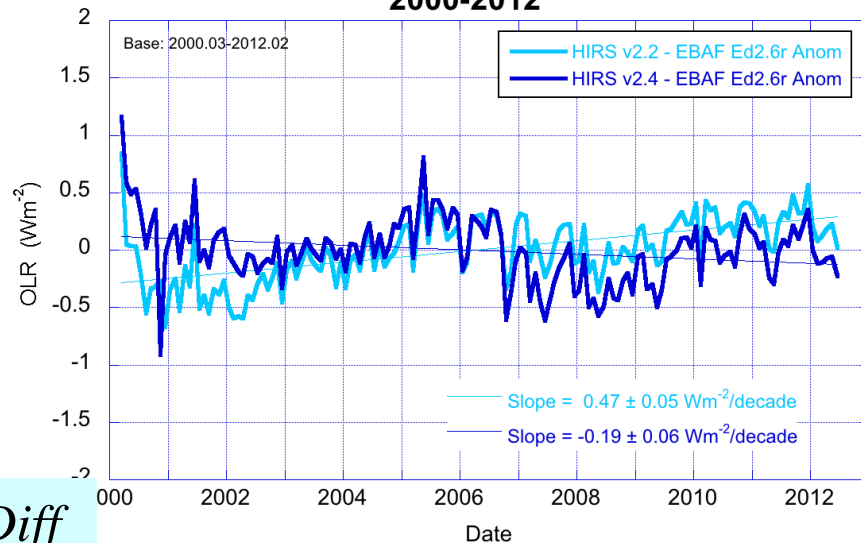


Anomaly

**Difference of Tropical Monthly OLR Anomaly
2000-2012**



**Difference of Global Monthly OLR Anomaly
2000-2012**

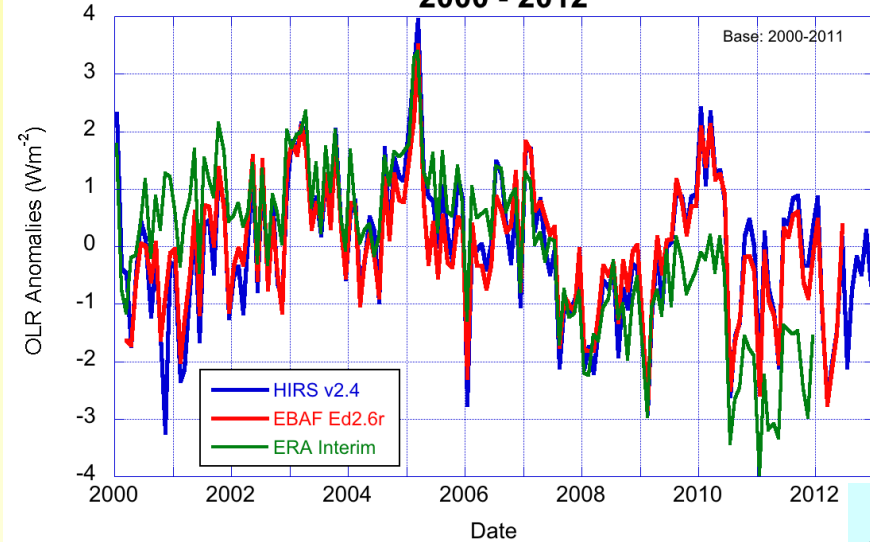


Anom Diff

Inter-comparison with EBAF & ERA-Interim

Tropical

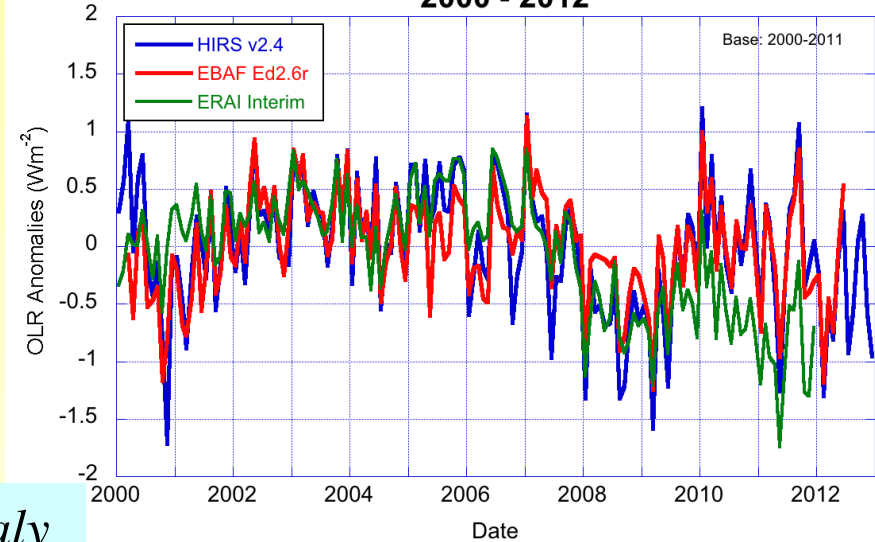
Tropical Monthly OLR Anomalies
2000 - 2012



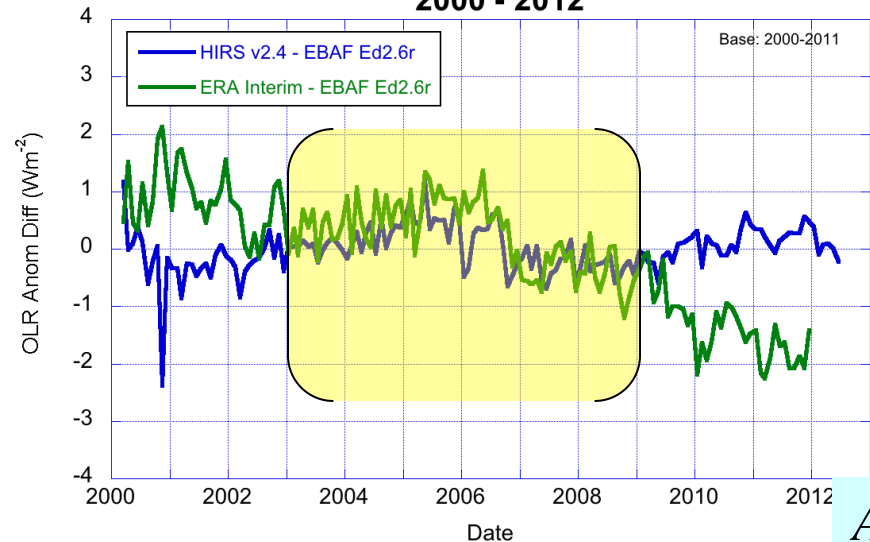
Anomaly

Global

Global Monthly OLR Anomalies
2000 - 2012

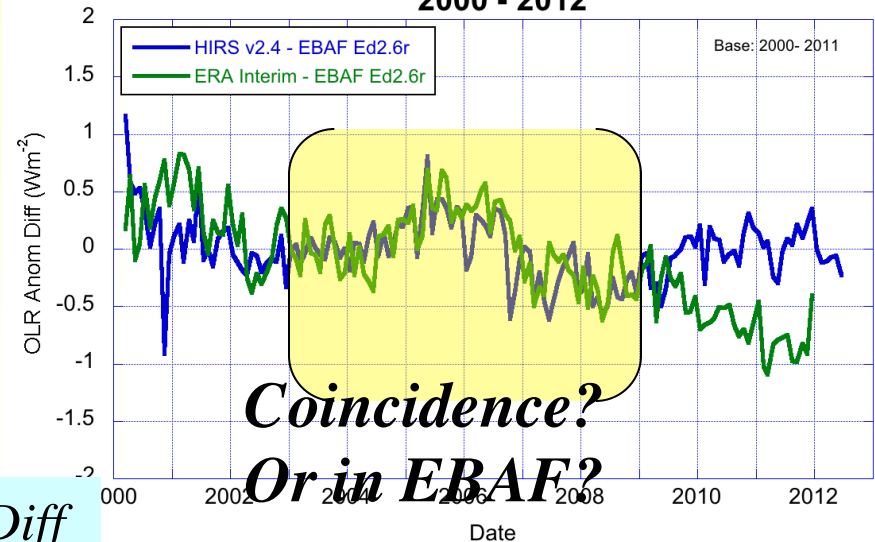


Difference of Tropical Monthly OLR Anomalies
2000 - 2012



Anom Diff

Difference of Global Monthly OLR Anomalies
2000 - 2012

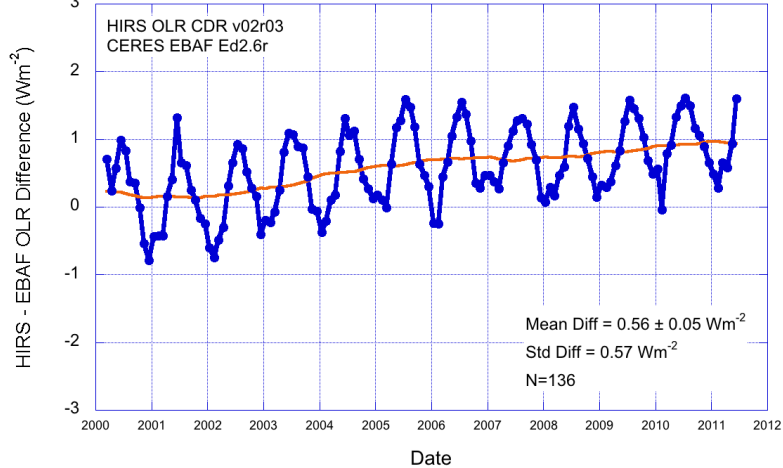


*Coincidence?
Or in EBAF?*

HIRS – EBAF OLR Differences

V2.3

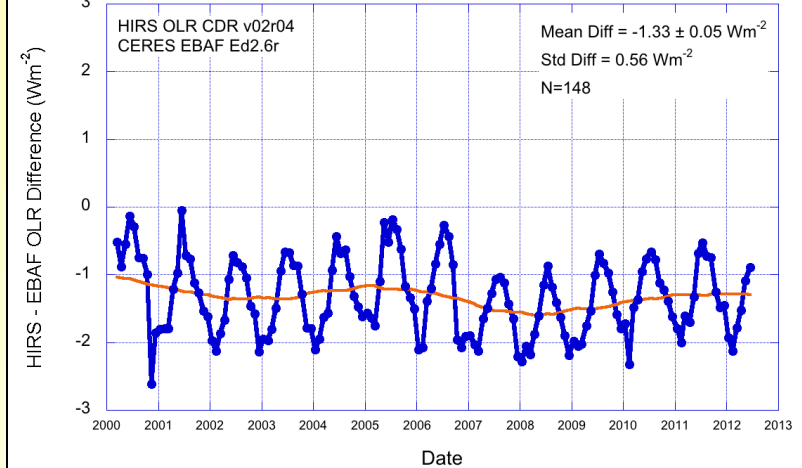
**Global Monthly Mean OLR Differences
2000.03-2011.06**



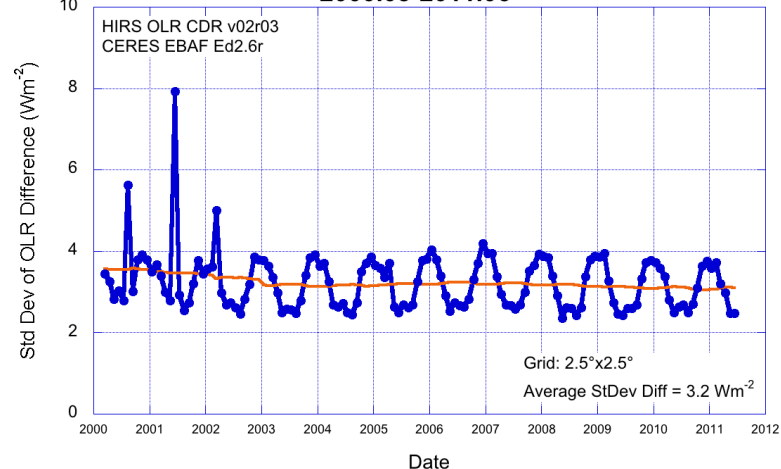
Ave

V2.4

**Global Monthly Mean OLR Differences
2000.03-2012.06**

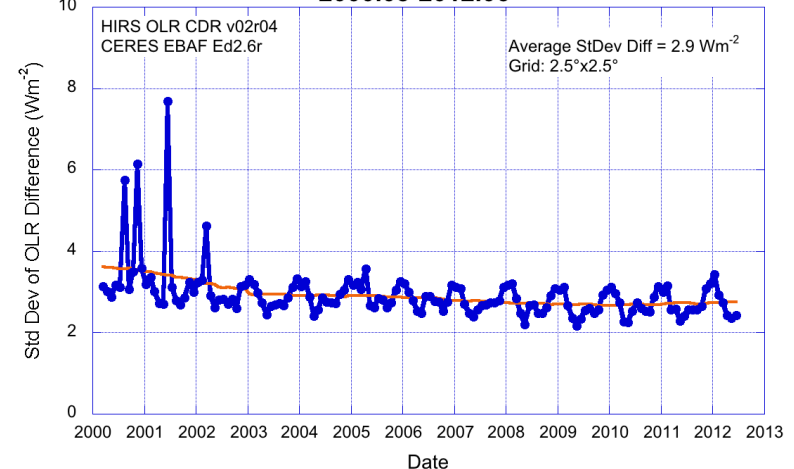


**Std Dev of Global Monthly OLR Differences
2000.03-2011.06**



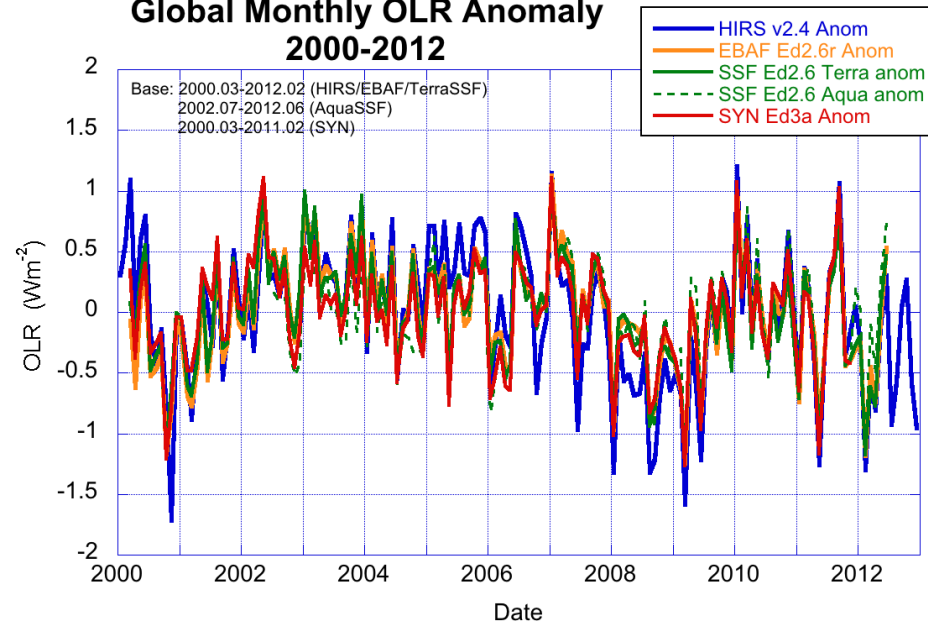
StdDev

**Std Dev of Global Monthly OLR Differences
2000.03-2012.06**

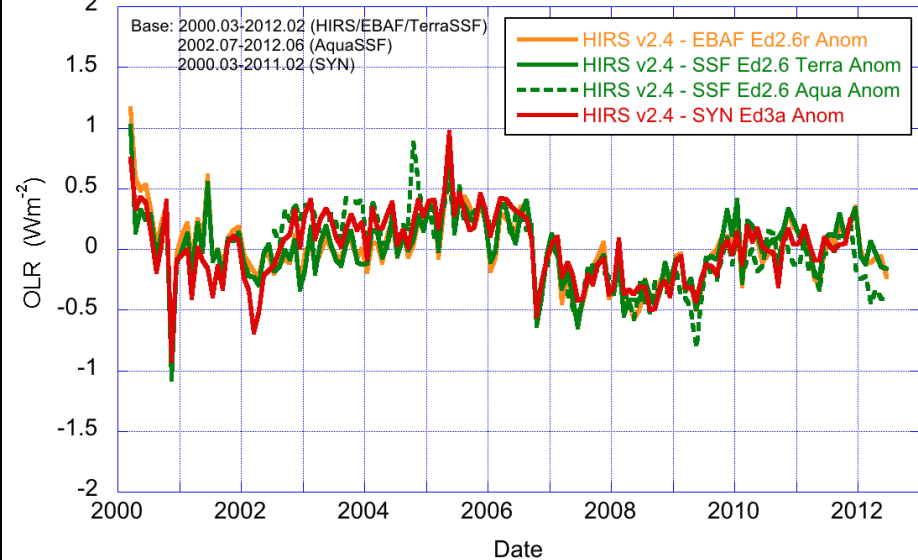


Global Monthly OLR Anomalies

**Global Monthly OLR Anomaly
2000-2012**



**Difference of Global Monthly OLR Anomaly
2000-2012**



**Slope of Diff $\pm 1-\sigma$:
Wm⁻²/decade**

HIRS v2.4 – EBAF Ed2.6r	-0.19 \pm 0.06 (2000.03-2012.06)
HIRS v2.4 – SSF Terra Ed2.6	-0.08 \pm 0.06 (2000.03-2012.06)
HIRS v2.4 – SSF Aqua Ed2.6	-0.62 \pm 0.08 (2002.07-2012.06)
HIRS v2.4 – SYN Ed3a	-0.14 \pm 0.07 (2000.03-2011.11)

Future Works

- Implement seasonal OLR model biases with more IASI data
- Release interim version of HIRS OLR CDR
- Revise OLR regression models using IASI emulated HIRS radiance as a test bed